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DESIGN AND STUDY OF MULTI-PURPOSE AGRICULTURAL MACHINERY PLANTS*

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I. Introduction

China's experience has witnessed that the emergence of multi-purpose agricultural machinery plant at the grass roots level is an inevitable result of the development of agricultural machinery industry. The agricultural machinery plants have been changing in scale and in function along with the growth of industry. However they change, they are commonly characterized by "multi-purpose" function which is of practical significance to China's rural construction. Therefore, it is worthwhile to study into the issue of planning and the establishment of multi-purpose agricultural machinery plant which is considered to be the start point of the agricultural machinery industry.

This paper presents two approaches to the planning of multi-purpose agricultural machinery plants, one of medium-scale and one of small-scale. The authors intend, by introducing and analysing these two approaches to study the proper concept, rational designing, appropriate technology and equipment for projecting a multi-purpose agricultural machinery plant. And also advance some points of importance to the establishment of such plant. Some data are also put forward for reference for those who intend to work out the layout of a specific multi-purpose agricultural machinery plant.

II. An Approach to the Planning of Medium-sized Multi-purpose Agricultural Machinery Plant

1. Production Task and Construction Scale

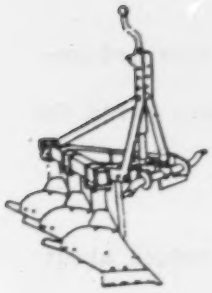
1) Service range: In China, at the grass root, the administrative unit is county which occupies a cultivated area, in the north part of China, about 60,000 hectares. The medium-sized multipurpose agricultural machinery plant should be able to serve the county by producing the main machinery equipment required in agricultural production and some allied production equipment and repair services for rural construction and peasants livelihood as well.

2) Representative Products: The factory should be able to produce fairly complicated machine-powered implements and also to produce various manual or animal-drawn farm implements and tools according to the requirements.

Take the following items as representative products:

1. tractor-drawn, light three-bottom plows
2. tractor-drawn, light harrows
3. tractor-drawn cultivators
4. rotary tillers
5. tractor-drawn grain drills
6. small harvesters
7. small threshers
8. hand sprayers
9. small power sprayers
10. small and medium pumps

Sketches of the products on the attached sheet



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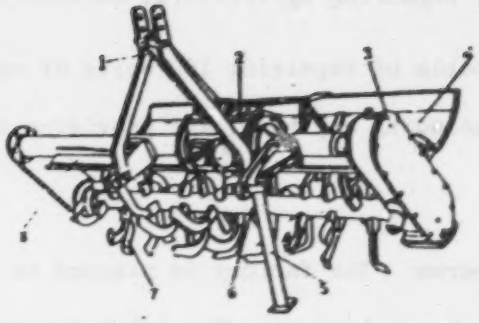

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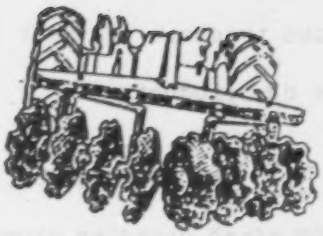

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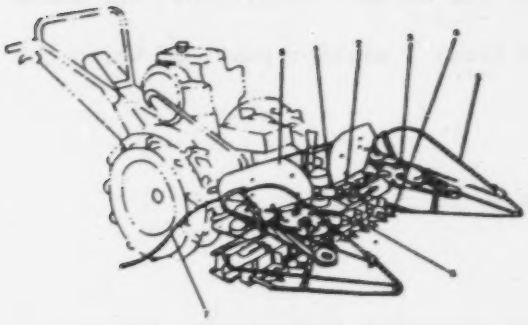

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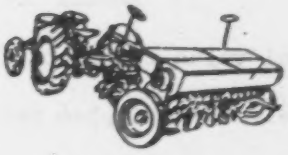

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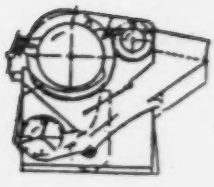

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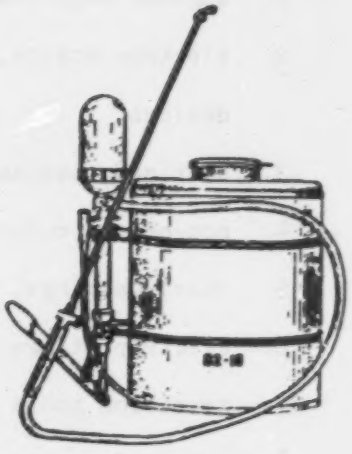

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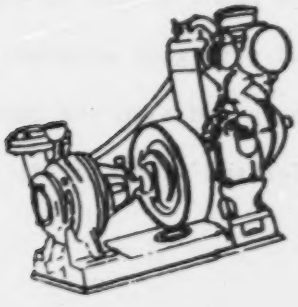

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3) Assignment for Repairing Agricultural Machinery

The factory is capable of repairing 100 units of various medium-sized tractors per year (including engines), and providing spare parts for its own products.

4) Production Program: The factory is planned to produce about 5000 mixed units as above representatives. The total weight of annual output is about 500 tons.

5) Annual Output Value: Under the China's conditions, the annual total value of output in normal case is about 5 million yuan, of which the repair value is 5-6 per cent.

6) Some Ancillary Component Parts to be Purchased

1. engines required
2. electric motors, electronic measuring instruments, control devices
3. bearings, standard parts for fastening, oil seals, chains, etc.
4. non-metal products such as rubber, plastics, leather, glass, etc.
5. steel castings, malleable cast iron, precision castings
6. electroplatings
7. precision tools
8. oxigen for gas cutting etc.

2. Plant Planning

Accoring to above production program, the plant should be equipped with fairly complete types of work in workshops and with good adaptability to making different types of agricultural machinery and also the machines with similar materials and manufacture technologies and with facilities for renewal

of products, for making proto-types and for reforming factory through self-reliance

1) Production Departments

Production is planned to be managed at two levels: plant and workshop. Under the plant, there are seven main production workshops:

1. Foundry shop --- The task is to produce iron castings and non ferrous metal castings used in products and maintenance equipment of this plant. Under the workshop there are groups: melting, moulding, cleaning, non ferrous metal casting and wood-working. The woodworking group can not only make wood pattern but also provide service for product packing and building maintenance.

2. Forging and heat treatment shop --- It consists of two parts: forging and heat treatment. The former is responsible for making forge peice for its own products, tool making and equipment repairing. The latter's task is to do heat treatment for forging pieces and the heat treatment for products, tools, dies and repair-parts.

3. Punching and Welding Shop --- It consists of two parts: punching and welding. The former is to cut, to form from sheet metal and section steel. The later takes the welding work for parts, components and assemblies, and also for non-standard equipment and steel structures.

4. Machine Shop --- It undertakes the machining work for castings, forge piece and other blanks. Some large equipment in this shop can do the machining work for repairing part also.

5. Assembly and Test Shop --- It should be able to perform the following operations for products: parts assembly, total assembly, adjustment test and painting.

6. Farm Machinery Repair Shop --- It ought to be able to repair and adjust tractors (including engines) and various kinds of farm machines, and to make some simple parts and accessories.

7. Tooling and Maintenance Shop --- It is the main auxiliary department of the factory and it should be able to make cutting tools, measuring devices, supplementary holders, jigs, fixtures, patterns, moulds and ordinary production equipment; to make accessories for repairing power equipment and other component and parts; to make non-standard equipment and mechanized transportation devices; to make prototype machines and to do some innovation work.

2) Management Sections

Generally, the factory has the following eight sections, which can either be merged or separated in accordance with specific condition.

1. General Office --- It executes the director's decisions, deals with every day business, in charge of administration, general affairs, welfare services, etc.

2. Production Planning Section --- In charge of products' planning controlling, statistics, handling semi-finished products and blanks, to make production well-coordinated.

3. Supply and Sale Section --- In charge of supplying raw materials, fuels, purchased parts; managing warehouses and transportation; selling products and servicing for customers after-sale.

4. Technical Section --- In charge of product design, production technology, technologic innovation, collecting information, product development. If necessary and possible, a product research institute can be set up.

5. Quality Control Section --- In charge of examining products' quality, appraising measuring instruments; chemical and physical testing for materials; managing metrological laboratory and physical-chemical laboratories.

6. Personnel and Security Section --- In charge of labour salary, transfer of personnel, checking work attendance, system of reward penalty, guard, etc.

7. Power Plant Section --- In charge of working out plant maintenance plan, ensuring safety in production; and managing power plants such as trasnformer and distribution substation, electric power station, pump room, etc.

8. Finance Section --- In charge of the whole factory's financial affairs, receiving and paying out money, cost accounting, and loss and profit analizing.

3) Technology Choice and Equipment Disposition

1. Casting

A large amount of grey cast iron is often required on farm machinery, general machinery, and the parts repaired in the factory. Considering production is sometimes unbalanced, technology and equipment to be chosen must have a large margin of flexibility.

It is suitable to equip with a blast furnace, 2 tons/h. The chamber size of the furnace can be changed and adjusted for the amount of molten iron. If necessary, a molten iron ladle can be built in front of the furnace so as to fit for producing a big casting (2-4 tons/ piece).

Generally, the materials to be fed to the furnace are broken manually except the large steel scraps, which can only be done by gas cutting. Weighing and charging can be simply mechanized. Pouring molten iron is mainly by hand.

The malleable cast iron and steel castings required in production are purchased.

If you have a good command of the production technology of nodular cast iron, you can use nodular cast iron instead of casting steel.

The white cast iron required in tillers' parts can be made by permanent mold, for common grey cast iron by sand mold casting.

Big castings are formed on the spot, and medium or small ones formed in sand-box. When a large numbers of castings are required, jolt-type moulding machines are used.

Core is man-made, and drying is done by means of a stove.

Sand shake-out, sand mixture are done continuously by a combined unit.

Top risers and burrs are eliminated generally by hand or grinder after cooling.

Then the castings are put into a cleaning barrel or put in the open for natural ageing.

If necessary, the water tight test can be done for castings in order to examine its quality.

The woodworking group should be quipped with universal machines such as gig saw, planer, and tenoning machines.

The wood parts and pattern making wood must be treated by steaming, boiling or natural seasoning so as to keep the wood parts from cracking and deformation.

A pot furnace with 100 kg must be set up for melting the non ferrous metal to meet the requirements of production and maintenance.

The fuel for heating depends on local conditions.

According to the production task the operations of casting department can be done by turns.

The annual output of the shop can reach 400-500 tons or more.

2. Forging:

The forgings of farm machinery production and repair parts are characterised by: great variety, simple technology, and small lot, we should give priority to free forging and hand forging.

When the parts are in batches, 30-40 or more, stamp forging technology should be taken.

The forging pieces from bar stock (Ø 30 mm), steel plate, and sectional steel should be heated beforehand.

When the hand tools such as sickles, picks, axes, spades are in mass production, the special equipment should be used for specialized production.

The equipment required in forging shop, should mainly be chosen in complete set. The medium-sized multipurpose agricultural machinery plant is better to choose electric air hammers of three sizes: 400 kg, 150 kg and 65 kg, and a friction press (300 tons), which is able to forge a gear blank of diameter over 100 mm. Various cutter handles, thin bars can be forged on a 150 kg or 65 kg air-hammer, press forming of plate steel can be done on friction press after being heated; for example, small mouldboard, harrow etc.

As for big forge pieces, it will be better by punchasing, because it is uneconomic to do this in the plant.

Coal stove is often used for heating forge-blanks in China's farm machinery factories. According to local conditions, gas stove, electric stove, and oil stove can also do.

Forging blanks and bars used in machining are cut off with a hack saw at the steel materials store.

The annual output of the forging shop can reach 200 tons or more.

3. Punching and Pressing:

Most of stampings in farm machinery are made of steel sheet, and some of them only need cutting, pressing and punching, without any other machining. A few stamping need drilling and tapping, we can set up a table drill by the side of stamping machine.

Shears with capacity less than 6 mm or with capacity less than 10 mm and combined stamping-shearing machines could be used for material-blanking, three-roller mill for plane-checking or rounding; 60 tons stamping machine for forming. Tubes and section steels can be cut off with some simple tools such as hand tube cutters, hand shears. Tube bending with die blank could be done by manual cold working. The burrs and edges of stampings are eliminated by hand or grinder.

4. Welding:

The majority of parts are welded with A.C. electric welder. Sheets are welded with spot welder.

As for section steels, non-standard equipment or mechanized devices, a complete gas welding set is better to be used.

The rectification of welding deforming is done by hand.

For a batch production, different types of welding jigs can be used.

Welding operations must be separated according to working stands and some smoke and dust hood units must be set up.

5. Heat treatment:

Since the working parts of farm machinery, such as cutters, mouldboards, harrows and blades are usually working in bad conditions, high quality is required. So great attention must be paid to the choice of technology and equipment. Quenching and tempering are in box-type electric furnace, carburizing in well-type gas carburizing furnace, tempering in well-type electric furnace, quenching in flush-electrode salt bath furnace, case hardening in a medium-sized high frequency furnace. It is necessary to have a quenching machine. Low-temperature tempering oil tank is not only for tempering but for cooling, aqueous alkali tank for cleaning putty, hand press for rectification, various hardometers for hardness test. All the above installations and machines can do heat treatment for common structural steel parts, some dies and gears.

For one year the shop can treat about 300 tons' parts.

6. Machining:

For the changeable products, the conventional production technologies are used. The machining of the general parts mainly depends on universal machine tools. In order to extend machining range, some different technologic devices are attached.

Specialized machine tools must be used to machine special parts in large numbers, for instance, knives, blades, etc. For the mass production and high quality, a specialized production line could be set up.

Whichever technology or equipment is chosen, it must ensure high quality and good economy.

The box-type parts are generally made of grey-iron castings, for which the milling machine can do surface rough and precision machining. The boring machine or lathe can do roughing and precision boring, the drilling machine can do drilling and tapping. When the production lot is large, special boring machines, special planing machines, and special jigs are used for ensuring the quality. Sometimes a production line which consists of simple and special machine tools will be set up.

Dish-type and drum-type parts and small shafts are mainly machined with engine lathe.

Varied parts of cast-iron or steel are mainly machined with turret lathe and milling machine.

As for special major shaft-type parts or large diameter parts, universal machine tools with some supplementary attachments are used.

Large machine tools are not equipped.

On farm machinery, cast-iron gears, stamping gears or sprockets are not machined, but for gears for high speed power transmission is machining then.

So the madium-sized multipurpose agricultural machinery plant should be capable of machining gears. For individual or small number of spur gear or bevel gears and spline shafts can be machined on universal milling machine. It is necessary to be equipped with gear hobbing machine (m 4) and gear shapper for production. For steel gears, after heat treatment, gearing in should be undertaken to improve the meshing engagement. Complete set for spiral bebel gear or machines for making precision gears, such as gear-shaving machine and gear-grinding machine, are not equipped in the shop. The sizes and specifications of gear machines in the machining shop and in the repair shop should be well coordinated to ensure full utilization.

Appropriate different size of engine lathes and turret lathes are properly selected.

Milling machines should be equipped with different size of working tables. Moreover, vertical and horizontal universal milling machines are necessary. Shapers with 500 mm stroke and double housing planer with 800 mm in width, can meet the requirement of surface machining for box type parts of the most farm machinery products.

For grinding machine, medium and small-sized internal grinders, external grinders, and face grinders are adopted.

For drilling machine, a few different size upright drills, bench drills and radial drills are quite enough.

Boring machines and shapping machines are generally of medium and small size. The total universal machine tools in machining shop are around 30 units. In pace with the development of new products the multipurpose agricultural machinery plant should often add some special machine tools self-made and some sophisticated machine tools bought from outside.

7. Farm Machinery Repairing:

The repairing of farm machinery is usually seasonal. Machines delivered to the plant in a busy farming season are required to be repaired in time. In order to solve the problems of making supplementary components and immediate repair for damaged parts, a small number of universal machine tools and common gas welding and electric welding should be equipped in this shop. The seriously damaged parts can be repaired in machining shop or tooling and maintenance shop.

As for repairing tractors (including engines), the wear parts, such as crankshafts, connecting rods, camshafts, pistons, piston pins, piston rings, bushes, cylinder sleeves, valves, fuel pumps and hydraulic units in tractors etc. are mainly repaired by replacing with new spare parts. Some simple, cheap, effective and advanced repair technology such as viscose mending, sealing, gluing could be used for repairing some special parts as cylinder blocks, etc.

In this shop, the cleaning, dismantling and mending tables for various components, such as the group of piston crankshafts, cylinder head, gear box, oil pump, hydraulic system and chassis, should be set up in accordance with the quantity of repairing jobs.

Water test stand, hydraulic dynamometer, static balance unit, should be set up for the checking. The stands of hydraulic system, electric system, fuel pump system for repairing adjustment and testing should also be set up. For the sake of convienence, mobile dinamometer should be provided and should be sent to the farms for checking the performance of the repaired units.

Tyre mending is a problem we often meet in the rural areas. A complete tyre mending equipment should be set up in the repairing workshop, if there is no other special maintenance shop near the plant.

8. Tooling and Maintenance

Equipment disposition should ensure the ability of tool manufacturing and equipment maintenance for normal production, and the ability to renew products and making special equipment to meet the development of the factory. The precision of machine tools in this shop is higher than that in machining shop. The specifications of machine tools here, such as vertical lathes, boring machines, gear-hobbing machines, can be coordinated with that in machining shop.

Holes of products and equipment with higher precision should be machined with precision milling machine.

Generally, coordinate boring machines will not be equipped because of its low utilization.

Some precision parts and the complicated cutting tools could be purchased.

9. Assembling and Testing:

Products are generally assembled by hand. Large-sized products or large lot of products should be assembled with fixed tables. Medium and small-sized products can also be assembled with a common assembly line or fixed tables. According to the different requirements of products, the factory can make some special assembly benches or test rigs. Before assembling, component or parts should be cleaned, and putty and burrs should be eliminated.

The painting, both for components and whole machine, could be performed with hand spray painting, brush painting or immersion painting, and then by natural drying. The painting room must be separated independently. A painting mixer should be equipped.

10. Metrology, Chemical and Physical Examination:

In order to ensure measurement instruments in normal condition, and to standardize the system of weighing and measuring, some standard instruments should be provided for checking length, weight, temperature, electric instruments. The high precision instruments can be sent to the measurement examining organization nearby for checking.

Physical and chemical experiment instruments and equipment needed in materials testing and microstructure observing should be equipped.

4) Working System

According to China's conditions, in major machining shops, two-shift workday system is instituted. In the shops of assembling, testing, forging, welding, farm machinery repairing are adopting, one-shift workday system. Three-shift workday system is instituted in heat treatment. Casting department is periodical working and production in turns.

5) Personnel Assignment

For basic production workers are assigned into groups for the key equipment workers are assigned to post. Worlers are asked to be an expert in one thing and good at many and also to be a "many-sided person" to meet the changeable requirements of products. According to Chinese eight technic-grade-system, the average grade of workers in multipurpose agricultural machinery plant should be above 4th grade.

In order to strengthen the capability for product design and improvement of production technology, and to meet the needs of production management, the factory must have a certain proportion of engineers and technicians, about 4-6 percent of total staff.

6) Factory Building

In the factory building, we should consider these important factors such as; the local conditions for constructing, the convenience for production and lowering the building cost.

Generally speaking, hot working shops are built independent with other, while cold working shops are merged into one building so as to reduce materials transportation and to make production units close by. In designing buildings,

the great attention must be paid to unified the construction parameters, such as column distance, span, and height, etc. As for reconstructing the old factory, we should order the overall planning study the particular problems and make rational use of the old buildings.

7) Public Facilities

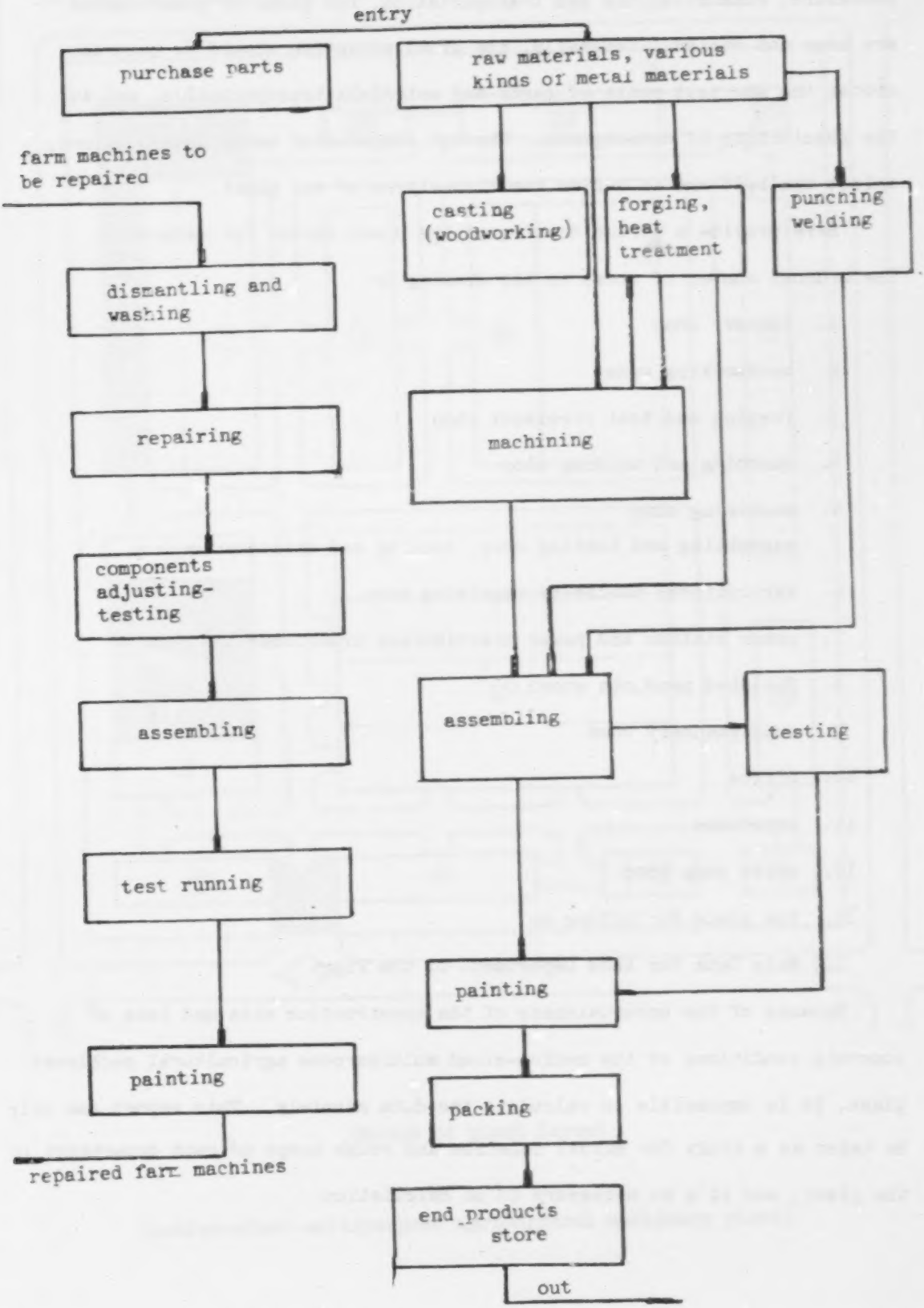
Since the electricity supply condition is not same in different localities, a spare diesel generator, with capacity about 30 percent of total power required is necessary in order to ensure safety in production.

According to local fuel resources, coal, oil, natural gas or electric may be used for heating process. Steam will not be used in production. As the amount of compressed air required is not large, it will not set up an air compression station, a movable air compressor is quite enough. In order to get the water required for production and livelihood, a water pump room or a water tower (or a high level water pool) should be built, if no utility water is available. Drainage problem will be solved on the basis of local conditions.

Business offices and living welfare facilities within the plant district should be under unified planning. The living welfare, culture and education facilities outside the plant district are handled by local society, so the items and cost of living quarters, public dining room, nursery, kindergarten are not included in this program.

6) Production Route

Production routes of general products and farm machinery repairing are as following:


entry
purchase parts
raw materials, various kinds of metal materials
farm machines to be repaired
casting (woodworking)
forging, heat treatment
punching welding
dismantling and washing
repairing
machining
components adjusting-testing
assembling
assembling
testing
test running
painting
painting
packing
end products store
out
repaired farm machines

9) Plant Layout

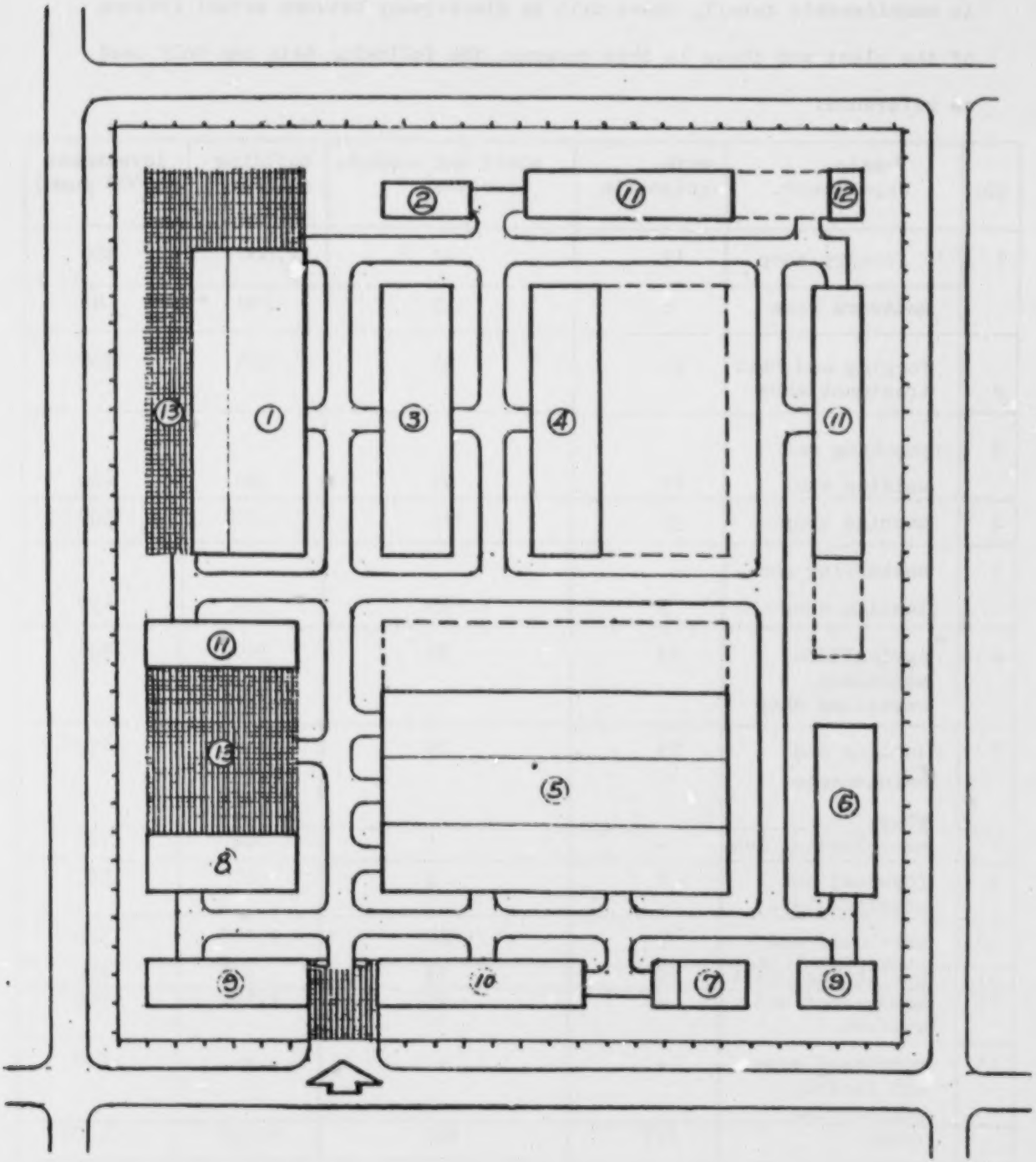
In line with the factors of organizations, topography, production procedure, communications and transportation, the plans of plant-layout are many and varied. Generally, the great attention should be paid to choose the shortest route of parts and materials transportation, and to the possibility of development. Through comparision among amany options, select the best one to define the disposition of the plant.

Here provide a sketch drawing of the plant-layout for reference. The ordinal number of items in the drawing is:

1. foundry shop
2. woodworking room
3. forging and heat treatment shop
4. punching and welding shop
5. machining shop
   assembling and testing shop, tooling and maintenance shop
6. agricultural machinery repairing shop
7. power station and power distribution transformation room
8. finished products store
9. supplementary room
10. office
11. warehouse
12. water pump room
13. the place for piling up

10) Main Data for Each Department of the Plant

Because of the uncertainness of the construction site and lack of concrete conditions of the medium-sized multipurpose agricultural machinery plant, it is impossible to calculate the data minutely. This report can only be taken as a study for mutual relation and rough scope of each department in the plant, and it's no necessary to do calculation.



Sketch of plant layout

(medium-sized multipurpose agricultural machinery plant)

in considerable detail, there will be discrepancy between actual factors of the plant and those in this program. The following data can only used as reference:

no.	main departments	main equipments	staff and workers (persons)	building area (m^2)	investment (1000 yuan)
1	foundry shop	13	42	1,000	300
	woodwork room	5	5	200	80
2	forging and heat treatment shop	20	35	460	300
3	punching and welding shop	12	27	500	180
4	machine shop	32	115	1,000	500
5	assembling and testing shop	5	35	500	150
6	agricultural machinery repairing shop	14	30	360	350
7	tooling and maintenance shop	19	25	360	170
8	metrological lab.	-	3	60	100
9	physical and chemical lab.	2	5	60	50
10	warehouse and transportation	5	20	2,000	320
11	public facilities	10	13	300	160
12	management and welfare	-	65	1,500	300
13	purchased area and factory engineering	-	-	-	240
	total	137	420	8,300	3,300

11) Main Data of the Whole Plant

Annual Output: (according to mixed units of representative products)	5000 units
Annual Production Weight (according to mixed units weight of representative products)	500 tons
Annual Total Value of Output (according to representative products, including farm machinery repair)	5 million yuan
The Total Number of Main Equipment:	135-140 units
of which machine tools:	45-50 units
forging and punching machines	12-15 units
The Total Number of Stuff and Worker:	400-450 persons
of which workers:	310-340 persons
Total Equipment Installation Capacity:	550-600 kw
Site area of the plant:	2.0-2.5 hectare
Building Area of the Plant	8000-8500 m^2
Annual Consumption of Essential Materials:	about 1000 tons
of which steel:	about 200 tons
pig iron	about 600 tons
Estimate of Capital Construction Investment (excluding the constructions outside the plant):	3-3.5 million yuan

III) An Approach to the Planning of Small-sized Multipurpose Agricultural Machinery Plant

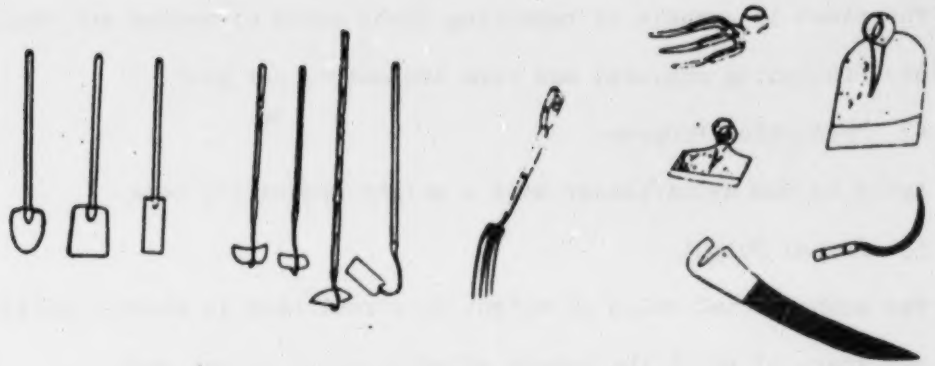
1. Production Task and Construction Scale

1) Service Range: According to the concrete situations, a small country which occupies the cultivated area about 30,000 hectares is taken as the service object of a small-sized multipurpose agricultural machinery plant. The plant should be able to produce the main machinery equipment required in agricultural production and to provide some allied equipment and repair services for rural construction and peasants livelihood as well.

2) Representative Products

1. hoe, shovel, spade, sickle, axe, etc. operated by hand
2. animal-drawn sigle-bottom plow
3. small-size animal-drawn cultivator
4. small-size animal-drawn drills
5. pedal or dual-purpose thresher
6. small rice and flour mill
7. small-size pump

Sketches of the Products on the Attached Sheet



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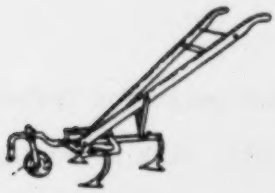

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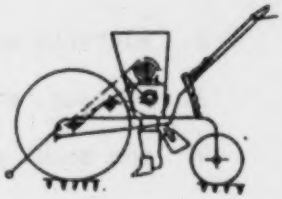

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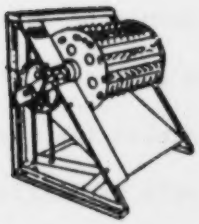

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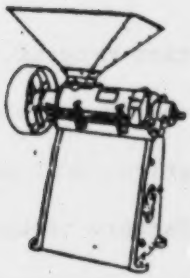

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3) Assignment for Repairing Agricultural Machinery

The plant is capable of repairing 60-80 units of medium and small-sized tractors (including engines) and farm implements per year.

4) Production Program

About 40,000 units/pieces with a weight around 330 tons.

5) Annual Output

The annual total value of output in normal case is about 2 million yuan per year, of which the repair value is about 15 per cent.

6) Some Ancillary Component Parts to be Purchased

1. engines required
2. electric motor
3. bearing, standard parts for fastening, chain, oil seal, etc.
4. non metal products, such as rubber, leather, plastics, etc.
5. large iron casting malleable cast iron and nodular cast iron
6. repairing for precision machine
7. oxygen for gas cutting

2. Plant Planning

According to above production program, the plant should be equipped with fairly complete type of work in workshops and with good adaptability to making different types of agricultural machinery and also the machines with similar material and manufacture technology, and with facilities for renewal of products, for making proto-types and for reforming factory through self-reliance.

1) Production Departments

Under the plant, there are five main production workshops

1. Foundry shop --- the task is to produce iron castings and non-ferrous metal castings used in products and maintenance equipment of this plant.

Under the workshop there are groups: melting, moulding, cleaning, nonferrous metal casting and woodworking. The woodworking group can not only make wood pattern but also provide wood parts for products packing and building maintenance.

2. Hot-working shop --- including forging, punching, welding and heat-treatment groups for products, tools and machine repair.

3. Machining and Assembling Shop --- including machining, assembling, testing and painting.

4. Farm Machinery Repair Shop --- it ought to be able to repair and to adjust medium and small sized tractors and various kinds of farm machines.

5. Tooling and Maintenance Shop --- it should be able to make cutting tools, measuring devices, supplementary holders, jigs, fixtures, patterns, moulds and ordinary equipment; to make accessories for repairing power equipment and other parts for non-standard equipment and mechanized transportation devices; to make proto-type machines and to do some innovation work.

2) Management Department

Generally, the factory has the following six sections, which can either be merged or separated in accordance with specific condition.

1. General Office --- it executes the director's decisions, deals with every day business, in charge of management, adjustment, general affairs, welfare services, etc.

2. Production Planning Section --- in charge of products' planning controlling, handling statistics, semi-finished products and blanks, to make production well-coordinated.

3. Supply and Sale Section --- in charge of supplying raw materials, fuels, purchased parts; managing warehouses and transportation; selling products and servicing for customers after-sale.

4. Technical Section --- in charge of product design, and development production technology, technologic innovation, quality control, machine maintenance, collecting information, etc. managing metrological lab. and physical-chemical lab.

5. Personnel and Security Section --- in charge of labor salary, transfer of personel, checking work attendance, system of reward, penalty, guard, etc.

6. Finance Section --- in charge of the whole factory's financial affairs.

3) Technology Choice and Equipment Disposition

1. Casting: A large amount of grey cast iron is often required on farm machinery, general machinery and the repairing parts in the factory. Among them box casting, machine body and frame parts constitude the majority. Most gears used for farm machienry are also castings.

Considering production is sometime unbalanced technology and equipment to be chosen must have a large margin of flexibility.

It is suitable to equip with a blast furnace 1.5 tons/h. when the casting quantity in production is changed, the camber size of the furnace can be changed and adjusted accordingly. If necessary, a molten iron ladle can be built in front of the furnace so as to fit for producing a bigger casting.

Generally, the materials to be fed to the furnace are broken manually except the large steel scraps which can only be done by gas cutting.

Weighing, charging and pouring molten iron are mainly by hand.

The common grey cast iron will be made by sand mold casting, sandbox modelling or on-site-molding casting. The white cast iron required in tillers' parts can be made by permanent mold for chilled casting.

Core is man-made, and drying in open air.

Top risers and burrs are eliminated generally by hand or grinder after cooling.

Sand shake-out and sand mixture are done by a combined unit. Then the casting are put into a cleaning barrel or put in the open for natural ageing.

A pot furnace with 50 kg must be set up for melting the nonferrous metal to meet the requirements of production and maintenance.

The woodworking group should be equipped with universal machines such as gig saw, planer and tenoning machines. The wood parts and pattern making wood must be treated by boiling or natural seasoning to keep the wood parts from cracking and deforming.

The annual output of the foundry shop can reach above 250 tons.

2. Forging: Many manual and animal drawn implements are forgings. We should give priority to free forging and hand forging for the small-batch production. Sometimes stamp forging may be properly used. For some large sized section material, press forming can be done after being heated. The small-sized maultipurpose agricultural machinery plant is better to choose electric air hammer with capacity 150 kg and 65 kg, and a friction press (160 tons). Hand-forging anvil may be provided to meet the requirement of the odd jobs and tool forging.

The annual output can reach 150 tons or more.

3. Punching: Most of stampings in farm machinery are made of steel sheet, and some of them only need cutting, pressing and punching, without any other machining. Some parts, the quantity of which is great and the machining is very difficult, will be purchased. Combined punching-shearing machine, punching machine with capacity 30 tons, three-roller mill as well as many other shearing and forming tools/die bolcks may be used for the punching operations.

4. Welding: The majority of parts are welded with A.C. electric welder. A complete gas welding set is better to be used. The rectification of welding deforming is done by hand. For a batch production, different types of welding jigs can be used.

5. Heat-treatment: In order to meet the requirements of the parts made of carbon steel and for the operation of quenching, tempering, normalizing and carburizing, it is necessary to use box-type electric furnace, well-type electric furnace and well-type gas carburizing furnace. The oil troughs and and water troughs can be used for hardening, cooling and low-temperature tempering. After heat-treatment, if necessary, the rectification of parts should be operated on the hand-press. Various hardometers for hardness test must be used. About 100 tons of parts can be treated per year.

6. Machining: For the changeable products, the conventional production technologies are used. The machining of general parts mainly depends on universal machine tools. In order to extend machining range, some different technologic devices are attached, the special parts with large lot would be machined by simple special machine tools.

The box-type parts are generally made of grey iron castings, for which milling machine can do surface roughing and precision machining, lathe can do roughing and precision boring, drilling machine can do drilling and tapping. The large box-type parts used for equipment maintenance should be machined on the small-sized double housing planer.

The general dish-type parts and small shaft-pin-like parts are mainly machined by lathe.

Varied parts of cast iron or steel parts are mainly machined with turret lathe and milling machine.

As for special major shaft-type parts or large diameter parts, universal machine tools with some supplementary attachments are used.

As for a few common gears hobbing machines may be used well coordinating with the equipment in tooling and maintenance shop.

The metal cutting machine tools used in the shop are of medium and small size in terms of specification and of common precision. Large machine tools are not equipped.

7. Assembling, testing and painting: Products are generally assembled by hand. Large-sized products or large lot of products should be assembled with fixed table. Adjusting and testing of components or whole machine should be carried out on the fixed table and position.

The painting both for components and whole machine could be performed with hand spray-painting, brush-painting or immersion painting and then by natural drying.

8. Farm machinery repairing: The repairing of farm machinery is usually seasonal. Machine dilivered in a busy farming season are required to be repaired in time. In order to solve the problem of making supplementary components and immediate repair for damaged parts, a small number of universal machine tools and common gas welding and electric welding should be equipped in the shop. The serious damage parts can be repaired in machine shop or tooling and maintenance shop.

As for repairing the medium and small size tractor (including engines), the wear parts, such as crankshafts, connecting rod, camshafts, pistons, piston pins, piston rings, bushes, cylinder sleeves, valves, fuel pumps and hydraulic units in tractors, are mainly repaired by replacement.

In the shop, the cleaning talbe, dismentling and mending tables for various components, such as the group of piston crankshafts, the cylinder head, gear box, the group of oil pump, hydraulic system and chasis, should be set up in accordance with requirements. Water test stand, hydraulic dynamometer, static balance unit should be set up for the checking. The stands of hydraulic system, electric system, fuel pump system for repairing, adjusting and testing should also be set up.

Some simple, cheap, effective and advanced repair technology such as viscose mending, sealing, gluing connecting could be used for repairing some special parts as cylinder blocks, etc.

For the sake of convenience, mobile dynamometer should be provided and should be sent to the farms for checking the performance of the repaired units.
A simple complete but mending equipment should be set up in the repairing workshop.

9. Tooling and maintenance: Equipment disposition should ensure the ability of tools manufacturing and equipment maintenance for production, and the certain ability to renew products and manufacturing special equipment to meet the development of the factory.
The precision of machine tools in the shop is higher than that in the machining shop. The specifications of machine tools here, can be larger than that in the machining shop. Boring machine and gear-hobbing machines must be coordinated with that in machining shop. Some precision parts and the complicated cutting tools could be purchased.

10. Metrology and chemical and physical examination: In order to ensure measurement instrument in normal condition, and to standardize the system of weighing and measuring, some standard instruments should be provided for checking length, weight, temperature and electric instruments.
Common physical and chemical experiment instruments and equipment needed for materials testing and microstructure observing should equipped.
The high precision instruments can be sent to the measurement examining organization for checking.

4) Working System

According to China's conditions, in major machining shops two-shaft workday system is instituted. In the shops of assembling, testing, forging, welding, farm machinery repairing are adopting one-shift workday system. Three-shift workday system is instituted in heat-treatment, casting department working is periodical and production in turns.

5) Personnel Assigned

For basic production workers are assigned into groups; for the key equipment workers are assigned to post. Workers are asked to be an expert in one thing and good at many and also to be a "many-sided person" to meet the changeable requirements of products. According to Chinese workers eight-technic-grade system, the average grade of workers in multipurpose agricultural machinery plant should be above 3-4th grade.

6) Factory Building

In factory building, we should consider the following important factors: the local conditions for construction, the convenience for production and lowering the building cost.

Generally speaking, hot working shops are independent with other buildings, while cold working shops are merged into one building so as to reduce materials transportation and to make production units close by. In designing buildings, the great attention must be paid to unify the construction parameters such as column distance, span and height etc. As for reconstructing the old factory, we should, under the overall planning, study the particular problems and make rational use of the old buildings.

7) Public Facilities

This plant lies mostly near the rural area where the power supply conditions are different from one another. A stand-by diesel generation set, with capacity about 30 percent of total power required is necessary in order to ensure safety in production.

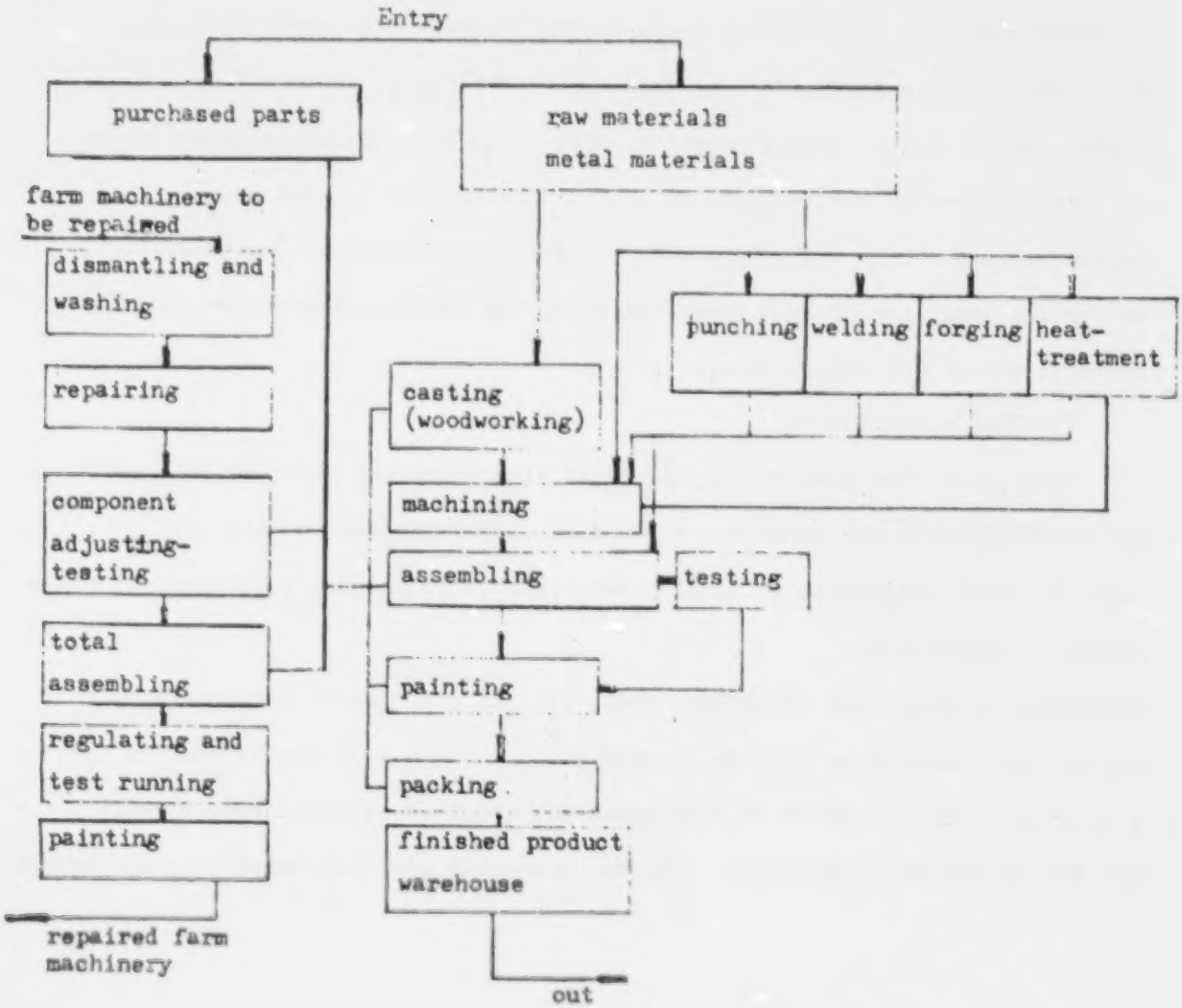
According to local fuel resources, coal, oil, natural gas or electricity may be used for heating process in production. Steam will not be used in production. As the amount of compressed air required is not large, it will not set up and air compression station, a movable air compressor is quite enough.

In order to get the water required in productionand livelihood, a water pump room or a water tower (or a high level water pool) should be built. Drainage problem will be solved on the basis of local conditions.

Business offices and living welfare facilities within the plant district should be under unified planning. The living welfare, culture and education facilities outside the plant district are handled by local society. So the items and cost of living quarters, public dining room, nursery, kindergarten are not included in the program.

8) Production Route

Production routes of general products and farm machinery repairing are as following:



9) Plant Layout

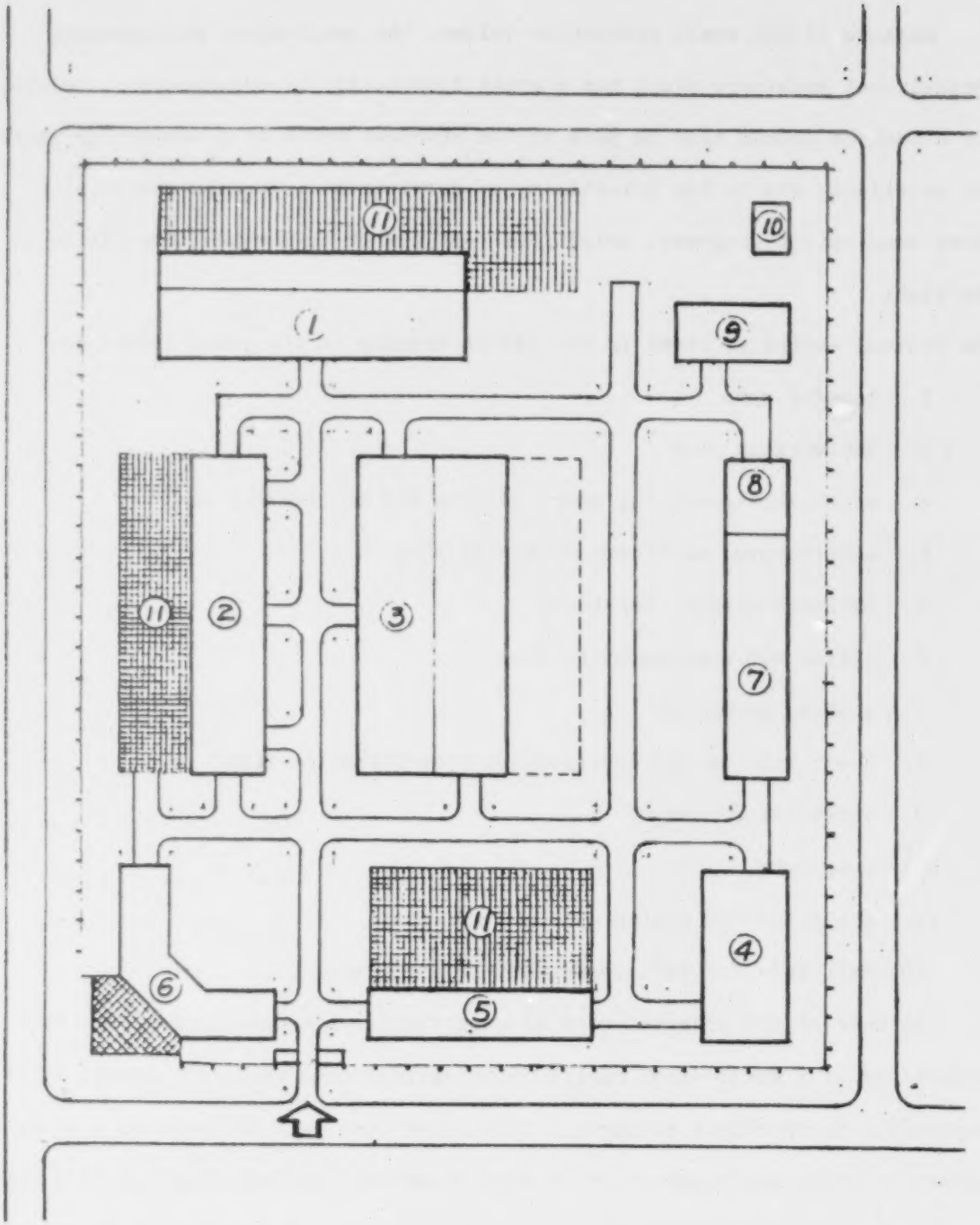
Because of the small production volume, the small-sized multipurpose agricultural machinery plant has a great flexibility in arrangement. Generally, our attention should also be paid to the shortest route of transporting parts and materials, and to the possibility of development. Through comparision among many option programs, select the best one to define the disposition of the plant.

The ordinal number of items in the sketch drawing of the plant layout is:

1. foundry shop
2. hot-working shop
3. machining-assembling shop, tooling and maintenance shop
4. agricultural machinery repairing shop
5. finished product warehouse
6. office and supplementary room
7. general warehouse
8. power station and distribution/transformation room
9. woodworking room
10. pump room
11. the place for piling up

10) Main Data for Each Department of the Plant

Because of the uncertainness of construction site and lack of concrete conditions of a small-sized multipurpose agricultural machinery plant, it is impossible to calculate minutely. This report can only be taken as a study for mutual relation and rough scope of each department in the plant and it's not necessary to do calculation in considerable detail. There will be discrepancy between actual factors of the plant and those in this program.



Sketch of plant layout

(small-sized multipurpose agricultural machinery plant)

No.	main department	main equipment	stuff and worker(persons)	building area (m^2)	investment (1000 yuan)
1	foundry shop	10	35	600	200
	woodwork room	4	4	120	50
2	hot working shop	24	32	600	290
3	machining-assembling shop	27	78	1000	400
4	agricultural machinery repairing shop	15	20	300	150
5	tooling repairing shop	10	22	300	240
6	metrological lab.	-	3	50	80
7	physics-chemistry laboratory	2	4	50	40
8	warehouse and transportation	5	15	1200	180
9	public facilities	8	10	300	100
10	management and welfare	-	40	1000	160
11	purchased area and factory engineering	-	-	-	210
	total	105	253	5520	2,100

11) Main Data of the Whole Plant

Annual output: (according to mixed units of representative products)	40,000 units/pieces
Annual production weight: (according to mixed units weight of representative products)	330 tons
Annual total value of output: (according to representative products, including farm machinery repair)	about 2 million yuan
The total number of main equipment:	100-110 units
of which machine tools:	35-40 units
forging and punching machines:	10-13 units
The total number of stuff and workers:	240-260 person
of which workers:	170-190 person
Total equipment installation capacity:	400-450 kw
Site area of the plant:	1.2-1.8 hectare
Building area of the plant:	5,000-5,500 m^2
Annual consumption of essential materials:	about 400 tons
of which steel:	about 150 tons
pig iron:	about 200 tons
Estimate of capital construction investment: (excluding the construction outside the plant)	2-2,2 million yuan

IV. Conclusion

The two design approaches in this paper present fairly complete and reasonable concept representing the general characters of multipurpose agricultural machinery plant. Some important points pertinent to the design of multipurpose agricultural machinery plant are discussed on purpose to offer samples which might be useful to those who are intending to build a plant of this kind.

These designs are worked out on the basis of China's practical conditions. For example, the investment for capital construction are only corresponding to China's current economic situation, and price policy. Besides, the speed of development of different plants, even of same scale, is varying owing to the differences in management competence and governmental support. In other words, whether a multipurpose agricultural machinery plant will meet with success in construction,operation, and development is affected by many and varied factors.

It is of great significance that a thorough investigation of both technical and economical feasility should be made in advance of projecting a plant. Effective government policy is of particular importantance to the development of multipurpose agricultural machinery plant.

V. Some Issues to be Discussed

The following issues are deemed worthwhile to be discussed on this meeting.

1. The range of functions and the prerequisites for construction of the multi-purpose agricultural machinery plant.

2. Relationship between the construction of multi-purpose agricultural machinery plant specialized production plant.

3. Rational system and method for repair of agricultural machines.

4. Appropriate measures to ensure good economic results for multipurpose.

5. Enhancement of international coorperation and promotion of construction of multi-purpose agricultural machinery plant.